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DRIVING METHOD FOR LIQUID CRYSTAL DISPLAY DEVICE
[EKISHO HYOJI SOCHI NO KUDO HOHO]

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Specification /1*

1. NAME OF INVENTION

DRIVING METHOD FOR LIQUID CRYSTAL DISPLAY DEVICE

2. CLAIMS

1) Liquid crystal display devices having

scanning electrodes and signal electrodes intersecting each other in the inside of a pair of baseboard,

liquid crystal aligned in between above-mentioned baseboard, and

display pixels formed where said scanning electrodes and signal electrodes face each other,

this invention proposes a driving method for liquid crystal display device, wherein

the polarity of electric voltage applied to said scanning electrodes and signal electrodes (hereafter, referred to liquid crystal driving voltage) is inverted at least once during the time to display one screen, and

no selection pulse of scanning waveform is applied to said scanning electrodes during the periods before and after inversion of the polarity.

3. DETAILED DESCRIPTION OF THE INVENTION

〔Field of Application〕

This invention relates to a driving method for liquid crystal display devices.

*Numbers in the margin indicate pagination in the foreign text.

〔Prior Art〕

Lately, liquid crystal display devices have advanced significantly. Advantageous characteristics of such liquid crystal display devices have been applied widely to large screen display devices for portable computers, word processors, and others. Thus, there are demands for liquid crystal display devices with number of time division of 100 (1/100 duty drive) or more, with good contrast, and without contract irregularity.

When multiplex drive was used for dot-matrix format liquid crystal display devices, display contract irregularity were generated by uneven waveform frequency distribution due to different display pattern. Therefore, a driving method, as was suggested by JP-A (Tokkai) S61-138990, for example, was used conventionally wherein the scanning waveform applied to the scanning lines inverted its polarity at every n scanning lines (hereafter, referred to "line inversion" method).

〔Problems to be Resolved by this Invention〕

As stated earlier, conventional technology (line inversion) can eliminate generated contract irregularity since the frequency distribution of the applied waveform is not uniform due to difference in display /2 patterns. But, this leads to another problem. Figure 5 shows waveform which is applied to the liquid crystal under 7-line inversion drive. All of the pixels are selected in this figure, which shows the timing of selection pulse and line inversion. The broken line shows the ideal waveform, while

the solid line shows the actual waveform which is not as crisp. Under this 7-line inversion, there are 7 types, A through G, of relationship between the selection pulse and the inversion of the line inversion. When the effective voltage of each waveform is compared, the effective voltage is the same among B, C, D, E, and F; G's effective voltage is lower than B, C, D, E, or F; and A's effective voltage is even lower than G. Because of this, there is a difference in the contract between the section where A or G waveform is applied and the section where other waveform is applied.

Figure 6 shows the applied line of waveform A when this was driven under the condition of 100 scanning lines and 60 Hz frame frequency. In Figure 6, the vertical axis shows the scanning line and the horizontal axis shows the screen (frame) number. If waveform A is applied to the 8-th scanning line on the n-th frame, the waveform A will also be applied to the scanning line number 7xm+1. The waveform A is also applied to the (7xm+6)th scanning line on the next (n+1)st frame; and the waveform A is also applied to the (7xm+4)th scanning line on the (n+2)nd frame. In this manner, the scanning line where the waveform A is applied changes with each frame. Thus, a moving scanning line with a contrast different from other part would be visible. How such contrast irregularity, visible due to the waveform A applied to the 99-th scanning line at n-th frame, moves with the changing frame (with passing time) is shown in Figure 7. The contrast irregularity visible on the 99-th scanning line of the n-th frame moves to the 97-th scanning line on the (n+1)st frame, to the 95-th scanning line on the (n+2)nd frame, and moves to the 79-th scanning line on the

(n+60)th frame (after one second). In other words the visible contrast irregularity seems to move from the bottom to the top of the screen within around 5/6 second. Since such contrast irregularity shows up at every 7-th scanning line, multiply horizontal stripes seem to move on the screen, which makes the display hard to see.

Further, when the line inversion number is set to other than 7, depending on the inversion number, such visible contrast irregularity may change its moving direction and speed, or might seem to stay on one scanning line. And, when the frame frequency is changed, the speed of the traveling contrast irregularity is also changed.

Although we discussed cases thus far where all of the pixels were selected, the same statement can be made even when normal display usage is being used.

〔Means of Solving the Problems〕

With respect to liquid crystal display devices having scanning electrodes and signal electrodes intersecting each other in the inside of a pair of baseboard, having liquid crystal aligned in between above-mentioned baseboard, and having display pixels formed where said scanning electrodes and signal electrodes face each other, this invention proposes to solve above-mentioned problem by inverting the polarity of the liquid crystal driving voltage at least once during the time to display one screen, and providing no selection pulse of scanning waveform applied to said scanning electrodes during the periods before and after inversion

of the polarity.

〔Embodiment〕

Figure 1 is a block diagram of an embodiment of this invention, where 1 is a conventional liquid crystal display device having a liquid crystal panel 2, an integrated circuit which drives the scanning electrode (hereafter, referred to scanning electrode driving IC) 3 of the liquid crystal panel 2, and an integrated circuit which drives the signal electrode (hereafter, referred to signal electrode driving IC) 4; and 5 is a conversion circuit which converts the display signals into the signals that can drive the scanning electrode driving IC 3 and the signal electrode driving IC 4 (hereafter, referred to liquid crystal display device driving signal).

With a liquid crystal device 1 so configured, display is made possible when display signals and control signals are converted to liquid crystal display device driving signals by the conversion circuit 5.

Figure 2 is a block diagram of an example circuit of a conversion circuit 5 of the embodiment, where 6 is a crystal oscillator, 7 is a dividing circuit, 8 is a driving signal creation circuit, 9 is a polarity switching circuit. Clock from the liquid crystal oscillator 6 is divided by /3
the dividing circuit 7, and the driving signal creation circuit 8 generates the liquid crystal display device driving signals from these multiple dividing signals. Further, signals from the driving signal creation circuit 8 are used to create signals to switch polarity of the liquid crystal driving voltage, which are synchronized by the delay clock and are output as FR.

FR is delayed by the delay clock cycle t_0 by passing through flip-flop 10, which generates FR', the driving voltage switching signal of this invention. Further, when the polarity of the FR is switched, a display prohibiting signal of $2t_0$ period, two cycle of delay clock, is generated by the flip-flop 10, exclusive OR 11, and NOT circuit 12. During this period, dividing signal input into driving signal creation circuit 8 is prohibited by an AND circuit 13, stopping the driving signal creation. By inputting display prohibiting signal to scanner electrode driving IC, all scanner output can be made into non-selection waveform.

In this way, as is shown in Figure 3, the display prohibiting signal, FR', and the scanner waveform applied to the scanner electrode before and after the polarity of the liquid crystal driving voltage is inverted by display prohibiting signal, can prohibit the scanner waveform selection period during the t_o both before and after the inversion of polarity.

Figure 4 shows the conventional scanner waveform before and after the inversion of liquid crystal driving voltage.

〔Advantageous Effect of the Invention〕

As stated above, this invention can eliminate the changes in effective value due to the slack in the waveform since there is no A and G waveforms, as is shown in Figure 5, due to the prohibition of selection pulse during the period before and after the polarity inversion of the liquid crystal driving voltage. Thus, this can eliminate the contrast irregularity and significantly improve the display quality.

4. BRIEF DESCRIPTION OF THE DRAWING

Figure 1 shows a general configuration of liquid crystal display device that is driven by the driving method for liquid crystal display device of this invention.

1 … Liquid crystal display device

2 … Liquid crystal panel

3 … scanner electrode driving IC

4 … Signal electrode driving IC

5 … Display signal switching circuit

Figure 2 is a block diagram of switching circuit that was used in the embodiment of this invention.

6 … Crystal oscillator

7 … Dividing circuit

8 … Driving signal creation circuit

9 … Polarity switching circuit

10 … Flip-flop

11 … Exclusive OR

12 … NOT circuit

Figure 3 shows the waveform of the embodiment of this invention.

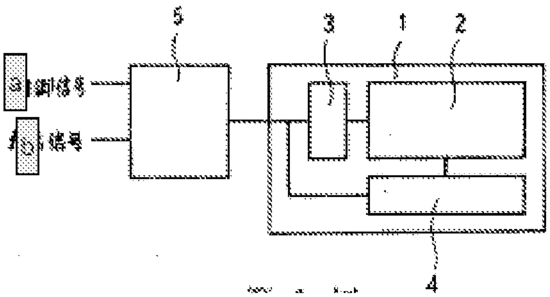
Figure 4 shows the conventional waveform.

Figure 5(a) (b) show conventional driving waveform of liquid crystal display device.

Figure 6 shows scanner line applied by the waveform A per each screen under conventional driving waveform.

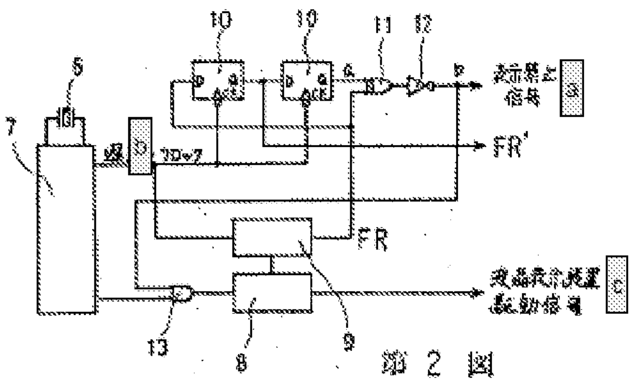
Figure 7 shows how the contrast irregularity travels with time under conventional driving waveform.

Figure 1:



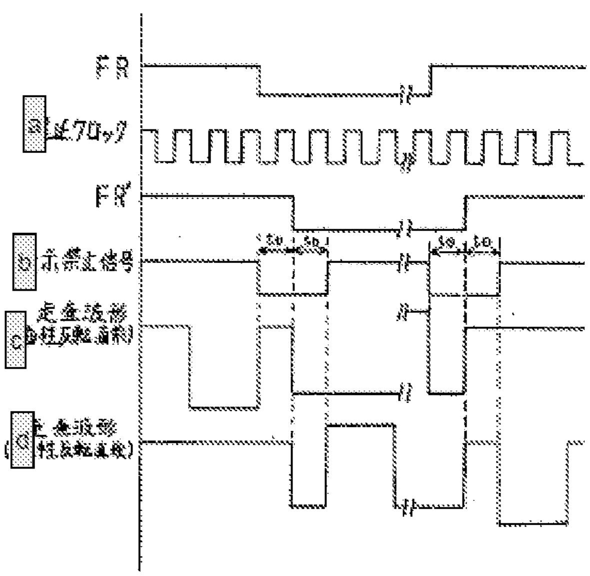
Key:
a) Control signal
b) Display signal

Figure 2:



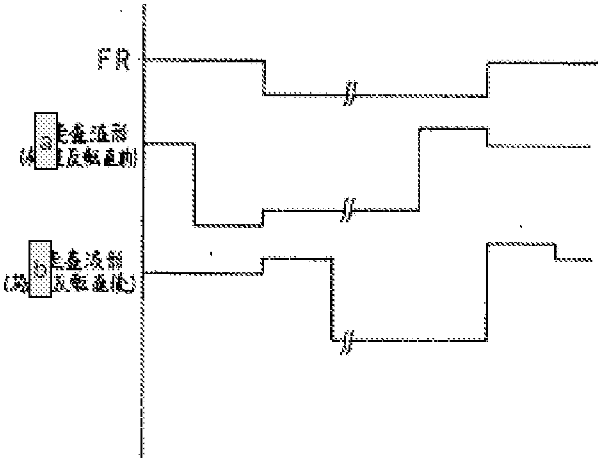
Key:
a) Display prohibiting signal
b) Delay clock
c) Liquid crystal device driving signal

Figure 3: /4



Key:
a) Delay clock
b) Display prohibiting signal
c) Scanner waveform (immediately before polarity inversion)
d) Scanner waveform (immediately after polarity inversion)

Figure 4:



Key:
a) Scanner waveform (immediately before polarity inversion)
b) Scanner waveform (immediately after polarity inversion)

Figure 5(a):

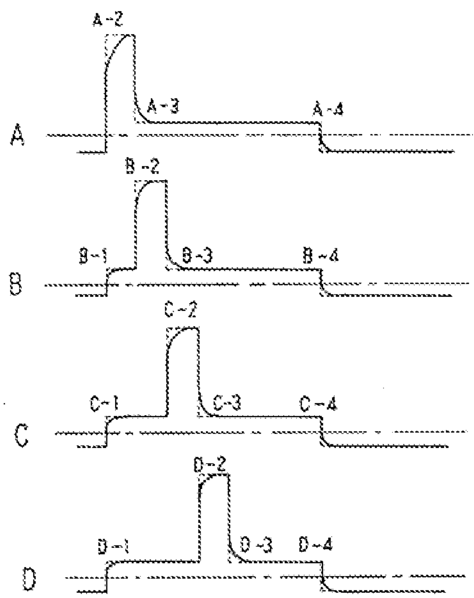


Figure 5(b):

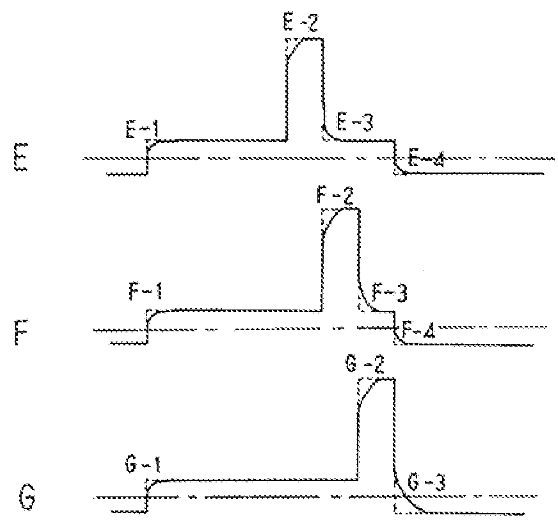
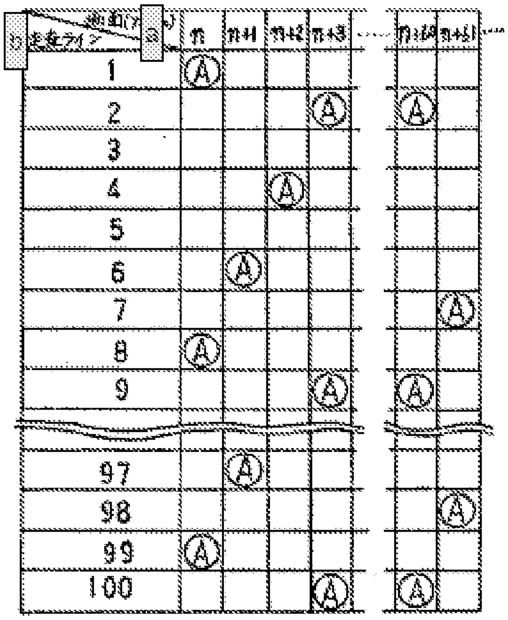
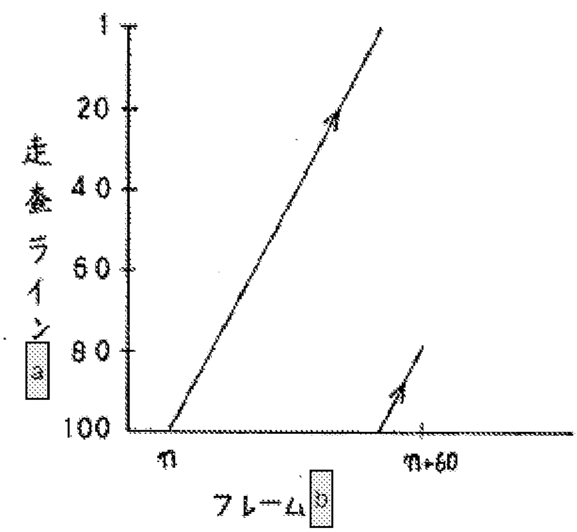


Figure 6:



Key:
a) Screen (frame)
b) Scanner line

Figure 7:



Key:
a) Scanner line
b) Frame